Original Article

Enhanced DNA Damages of Human Prostate Cancer Cells Induced by Radiofrequency Capacitive Hyperthermia Pre- and Post X-rays: 6 MV versus 15 MV

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Abstract

Objective: This study aimed to determine the effect of 13.56 MHz radiofrequency (RF) capacitive hyperthermia (HT) on radiosensivity of human prostate cancer cells pre and post X-ray radiation treatment (RT).

Materials and Methods: In this experimental study, the human prostate cancer cell line DU145 was cultured as 300 µm diameter spheroids. We divided the spheroids into group I: control, group II: HT at 43˚C for 30 minutes (HT), group III: 4 Gy irradiation with 6 MV X-ray [RT (6 MV)], group IV: 4 Gy irradiation with 15 MV X-ray [RT (15 MV)], group V: HT+RT (6 MV), group VI: HT+RT (15 MV), group VII: RT (6 MV)+HT, and group VIII: RT (15 MV)+HT. The alkaline comet assay was used to assess DNA damages in terms of tail moment (TM). Thermal enhancement factor (TEF) was obtained for the different treatment combinations.

Results: Mean TM increased with increasing photon energy. Group II had significantly greater TM compared to group I. Groups III and IV also had significantly higher TM compared to group I. Significant differences in TM existed between groups V, VII, and III ($P<0.05$). We observed significant differences in TM between groups VI, VIII, and IV. TEF values demonstrated that enhanced response to radiation was more pronounced in group V compared to the other combined treatments.

Conclusion: Our results suggest that HT applied before RT leads to higher radiosensivity compared to after RT. HT at 43˚C for 30 minutes added to 6 MV X-ray causes higher enhancement of radiation compared to 15 MV X-ray.

Keywords: Prostate Cancer, Comet Assay, Hyperthermia, Radiation, Spheroid

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Introduction

Hyperthermia (HT), at a temperature range of 42-45˚C, is a potent radiosensitizer that can cause irreversible damage due to protein degradation and the lack of DNA double-strand break (DSB) repair in cells (1, 2). Increasing use of HT has led to a need to develop new devices that treat deep seated tumors such as prostate cancer. However, HT is limited in clinical therapy because of the difficulties to target this approach to the tumor volume. Radiofrequency (RF) capacitive HT combined with radiotherapy (RT) is recommended as treatment for prostate cancer. In the 13.56 MHz capacitive coupling electro HT system, a part of the patient's body is placed as the dielectric material between both electrodes of the device. Consequently, heat is generated in the tissue (3). Cancer tissue has certain physical properties that Which makes its temperature goes higher than normal tissue (4); actually, autofocusing occurs. External radiation therapy is usually applied